

cc: DD/OSA
D/Tech

4 January 1966

Job 89B00708R
Box 9
Folder 108.

To: Gen. Jack Ledford

From: Kelly Johnson

Subject: Lockheed Recommendations on Changes in Operating Procedures Resulting from Aircraft #126 Accident.

Dear Jack:

In the last several days, I have studied intensively all aspects which led to the loss of aircraft #126, and have investigated what steps should be taken to remove the causes which led to this accident.

The cause of the accident was that the wiring to the pitch and yaw gyros in the stability augmentation system was reversed, which made the aircraft uncontrollable immediately upon lift-off. The accident board has provided you with the statements of those involved in all phases of this regrettable accident and I do not intend to elaborate on their findings here. I would like to present my views on steps that should be taken to prevent mis-wiring in the control system in the future.

A. Prior to resumption of flying, I recommend that the following steps be taken.

1. We will install riveted type collars on the pitch rate gyro cabling connectors. These will make it impossible for them to be incorrectly installed on the yaw rate gyro. The SR-71 has a similar type of collar which currently is assembled using screws. I'm afraid that these can be readily removed and we should go to the riveted type.

2. In addition to the 3/8-inch high lettering which is on the cables, stating which is the pitch and which is the yaw cable, we will color code the cable assembly in the gyro box. All gyro packages will be painted with yellow for the yaw gyro and blue for the pitch gyro. Printed on these units in large letters will be the proper designation, "pitch" and "yaw." I should state that the gyro packages currently have a nameplate which differentiates pitch and yaw, but the lettering is small.

3. New ground wires will be installed, as we have found several in our inspections which have been worn in service.

4. Our maintenance manual will be amended to incorporate additional detail on all phases of removal, installation and checkout of the SAS.

5. a. We have devised a procedure whereby with electrical and hydraulic power on the aircraft the over-all end-to-end operation of the yaw channel can be checked readily. This is done by loosening two mounting screws on the yaw gyro and rotating the gyro can slightly. There is enough play in the bolt holes to allow gyro operation of the rudders to the extent of showing a 5-inch travel on the leading edge.

b. We are investigating the possibility of a similar simple check on the pitch channels but have not completed our tests.

c. I do not recommend that these be pre-flight checks, but they should be done always when the SAS gyros or wiring have been worked on. I do not know of any reasonable check which can be done as a pre-flight test with the current equipment, although we will continue to investigate the possibilities of devising a reasonable test which will not subject the gyros to damage in the course of testing.

6. A written inspection procedure will be devised to insure proper inspection and witnessing of the removal, re-installation and checkout.

B. Concurrently with the above, we are undertaking the following program.

1. An investigation of all other installations which affect flight safety where wires or plumbing can be interchanged easily. I should tell you that last summer we instituted a complete program of color coding all important wires and plumbing connections in the aircraft. Unfortunately, many of these items were not done during the modification program on the A-12 vehicles. We have had one case where the color coding was applied improperly which caused a false hookup in the landing gear circuit. I believe, nevertheless, that color coding is definitely a desirable thing to do.

2. We are investigating whether or not wires to the transfer valves can be interchanged and, if so, what would result. We are looking particularly at the pitch and roll transfer valves on the inboard elevon servos and the LVDT's.

3. The landing gear selector valve and the landing gear door valve are identical type units and might be improperly wired. This would lead to a closing of the inboard doors without operation of the main landing gear. While not a safety-of-flight item, steps will be taken to prevent mis-wiring of these valves and, of course, our procedure for operating the landing gear on the ground whenever any work is done on the gear should prevent mis-wiring.

4. Our investigation has turned up the facts that the nose hatch seal lever in the cockpit can be installed two different ways, one of which is incorrect. We will make a modification to prevent this.

5. The pitot static valve lever in the cockpit and associated linkages and valves can be assembled incorrectly, if our instructions are not followed.

6. Ground test selector valves on the Q-bay and cockpit pressure regulators can be mis-installed. This could result in pressurization failure in flight. We will correct this.

You might consider that the above indicates very serious design deficiencies in many areas of the aircraft. This is not true. For instance, the wires which were mis-located on the improper SAS gyros are marked "pitch" and "yaw", while the individual plugs coming out of the main cables are marked for "pitch A," "pitch B," "pitch M," with similar markings for the individual plugs to the yaw gyro. The gyro packages themselves have nameplates indicating their functions and there is additional marking on the individual plugs indicating whether they are J-1, J-2, or J-3, for both the pitch and yaw final connectors. These are matched by similar indications on the gyro cables. Likewise, the usual aircraft practice of numbering individual wires was followed to make connections to the pins at the plugs. This is true in all the other cases I have noted above, but we are finding as our aircraft become more and more complex that we have an increasing problem training even experienced people to follow good practice.

For instance, the inspector who signed off the installation on aircraft #126 we considered to be a competent inspector, having some seventeen years of experience in the aircraft business. The mechanic who connected up the wires improperly had seven years of experience and much of it on aircraft with complicated electrical systems, such as the Constellation.

It is unfortunate that some time back, in order to keep from damaging the gyros, M-H, with our concurrence, elected to go to a checkout of the wiring in the SAS system which did not carry through to the point where the surfaces were actuated. In fact, we still have on some aircraft a means for mechanically operating the gyros in a manner which can be used to see the actual control deflections. This system, however, also depends upon careful operation by the operator and led to problems in re-setting the gyros to their zero position and, in certain cases, were used in a manner to effect hard-over signals, which damaged the gyros.

At the present time, neither M-H nor we are prepared to recommend an "end-to-end" pre-flight check which can be applied readily to the existing system. We do, however, agree that the means proposed above should be used to check out the system when the gyros have been removed or the wiring in the gyro cans disconnected.

In summary, I feel that the changes made in the gyro cabling and identification, together with the yaw gyro check, are a complete answer to the problem of mis-wiring which caused the accident to aircraft #126.

Sincerely,

A handwritten signature in cursive script, reading "Kelly Johnson". The signature is written in dark ink and is positioned to the right of the word "Sincerely,".

CLJ:vmp